REMARKS

The specification has been amended to correct the use of a wrong word on page 1.

Claims 1-12 were rejected under 35 U.S.C. §112 for use of the phrase "image frame-to-image frame" in Claim 1. This phrase has been corrected. It is respectfully submitted that the claims are now clear and definite.

Claims 1-12 were rejected as anticipated by two of the patents which applicant submitted in his information disclosure statement at the time of filing of this application. Both patents are owned by the assignee of the present application and are clearly distinguishable from the present invention.

Claims 1-2, 5-9, and 10-12 were rejected under 35 U.S.C. §102(b) as being anticipated by US Pat. 4,887,306 (Hwang et al.) Claim 1, the only independent claim in the application, describes a method of displaying an ultrasound image with adaptive persistence, comprising obtaining a plurality of component image frames of body tissue or fluids; determining the extent to which at least one portion of each component image frame varies from one image frame to another image frame by assessing the frame-to-frame misregistration of one or more component areas of temporally different image frames; combining a plurality of the component image frames to provide a composite image frame, the number and/or weighting of component image frames that are combined in at least one area of the composite image frame being a function of the determined extent to which at least one portion of each component image frame varies; and displaying an image corresponding to the composite image frame. As explained on page 1 of the application, image persistence can improve the visualization of structure in the body which might be very faintly shown due to weak echo signals as may be received from tissue at greater imaging depths or reflected from fine tissue

structure. A good example of tissue with these characteristics is the mitral valve 220 as explained in the paragraph beginning on page 8, line 30 of the specification. This paragraph compares image areas 254, 256, 258 of the heart wall which do not vary greatly from frame to frame and benefit from only moderate persistence, with the mitral valve 220 in image area 260 which moves rapidly as the heart beats and would appear blurred with moderate persistence. The mitral valve area is thus displayed to best effect with very little persistence to prevent blurring.

Hwang et al. describe an ultrasound system with an adaptive temporal filter that is different from the method of the present invention in at least two major respects. One is that the temporal filter is responsive not to areas of an image but only to a single pixel location. This means that an image of low resolution such as a 640 pixel by 480 pixel image would effectively be processed by over 300,000 independently operating filter functions. Overall anatomical motion is ignored as each filter responds in accordance with pixel intensity at its own unique pixel location.

A second difference is that the Hwang et al. filter preferentially filters pixels of low pixel intensity with high persistence and pixels of high pixel intensity with low persistence. See Hwang et al. at column 5, lines 27-39 and 65-66. This choice is based on the recognition that pixels of low intensity are more likely to be dominated by the speckle pattern of the image at that point, whereas high pixel intensities from highly echogenic specular reflectors are less contaminated by speckle. See Hwang et al. at column 2, lines 50-62. However, this can lead to an opposite result as that intended by the present invention as alluded to above. In the aforementioned case of the mitral valve leaflets, echoes from this delicate heart structure are much fainter and less intense that those from the neighboring heart wall. A Hwang et al. filter will response to these low intensity signals

with a high degree of persistence. But the rapid motion of the mitral valve leaflets will, with high persistence, result in a blurred display of the action of the valve. This condition would not arise if the filter were to respond to regional motion rather than signal intensity.

The method of the present invention as described in amended Claim 1 operates differently from Hwang et al. and prevents this problem. In the claim the inventive method analyzes a "portion" or "area" of an image and not just a single pixel. An example of this is given in the paragraph spanning pages 8-9 of the specification with reference to Figure 4B, where the heart image is divided into a plurality of image areas shown by the dots over the image. These dots divide the image into a nine by twelve grid of 108 image areas, and one or group of these areas are assessed for frame-to-frame misregistration, a measure of regional motion. For a low resolution 640 pixel by 480 pixel image, each of these areas would contain over 2800 pixels, enough to gauge the motion of anatomy in a region of the image. For the higher resolution typically found in diagnostic ultrasound systems, even more pixels would be involved in the assessment. Component image frames are then combined in the area on the basis of this area frame-to-frame misregistration and not on the basis of one pixel. If the image area contained the rapidly moving mitral valve leaflets, for instance, the misregistration due to motion would be high despite the low intensity of reflected echoes, resulting in low or no persistence in the area where the leaflets are being displayed. Blurring of the motion of the valve would thus be prevented. For these reasons it is respectfully submitted that amended Claim 1 and its dependent Claims 2-12 cannot be anticipated by Hwang et al.

Claims 1-12 were also rejected under 35 U.S.C. §102(b) as being anticipated by US Pat. 6,126,598 (Entrekin et al.) Entrekin et al. describe an ultrasound system which reduces

speckle by spatial compounding and has two modes of operation: a "survey mode" in which the degree of compounding is reduced as a scanhead is moved over the body in search of the target anatomy, and a "study" or "targeted" mode in which the degree of compounding is increased as the scanhead is held stationary over the target anatomy as the target anatomy is being carefully diagnosed. Blurring will occur if compounding is performed while the scanhead is moving, but this is not the case in the study mode when the scanhead is held stationary. To prevent this blurring, the Entrekin et al. system automatically switches to the survey mode of spatial compounding when the scanhead moves. Because scanhead motion is the determining factor for automated mode switching and scanhead motion can be detected by image analysis of the frame-to-frame variation of the image (when the scanhead moves, each frame will view different anatomy from the new scanhead position), frame-to-frame misregistration is analyzed as it is in the case of the present invention. And since scanhead motion will cause every pixel in the image to view different anatomy, only a single area need be used for a sum-of-the-absolute-difference computation, as shown in Figs. 3, 4, and 5 of Entrekin et al.

Spatial compounding as performed by Entrekin et al. is one of the unique ways of compounding, relying as it does on the different speckle pattern exhibited by the same tissue when viewed ultrasonically from different directions. The present invention is directed to temporal compounding and particularly adaptive persistence as the claims state, not spatial compounding. The different compounding techniques are viewed as different and distinctive approaches in the art, as is evident from the first column of the Hwang et al. patent where Hwang et al. compare and contrast spatial compounding, frequency compounding, and temporal compounding and their specific pros and cons. In the present application frequency compounding is specifically described at the top of page 4 as

a separate function of the embodiment of Fig. 1 for speckle reduction, distinct and separate from the persistence processing function which has as its purpose the enhanced visualization of faintly perceived anatomy. It is therefore respectfully submitted that the claimed invention is drawn to adaptive persistence as the claim language states, is used to enhance the visualization of faintly received signals (page 1 of the specification) and not speckle reduction, is not drawn to spatial compounding or look direction diversity, is directed to the problem of the blurring of rapidly moving tissue and not scanhead motion, and that one skilled in the art would recognize it as such. For these reasons it is respectfully submitted that amended Claim 1 and its dependent Claims 2-12 are not anticipated by the spatial compounding system of Entrekin et al.

In view of the foregoing amendments and remarks, it is respectfully submitted that Claims 1-12 are now clear and definite and that Claims 1-12 are not anticipated by Hwang et al. or Entrekin et al. Accordingly it is respectfully requested that the rejection of Claims 1-12 under 35 U.S.C. §112 and §102(b) be withdrawn.

In light of the foregoing amendment and remarks, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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